

RNA and PROTEIN SYNTHESIS

Chapter 13

DNA

- Double stranded
- Thymine
- Sugar is Deoxyribose

RNA

- Single stranded
- Uracil
- Sugar is Ribose

- Types of RNA

1. Messenger RNA (mRNA)

- Carries copies of instructions from DNA to ribosomes

2. Ribosomal RNA (rRNA)

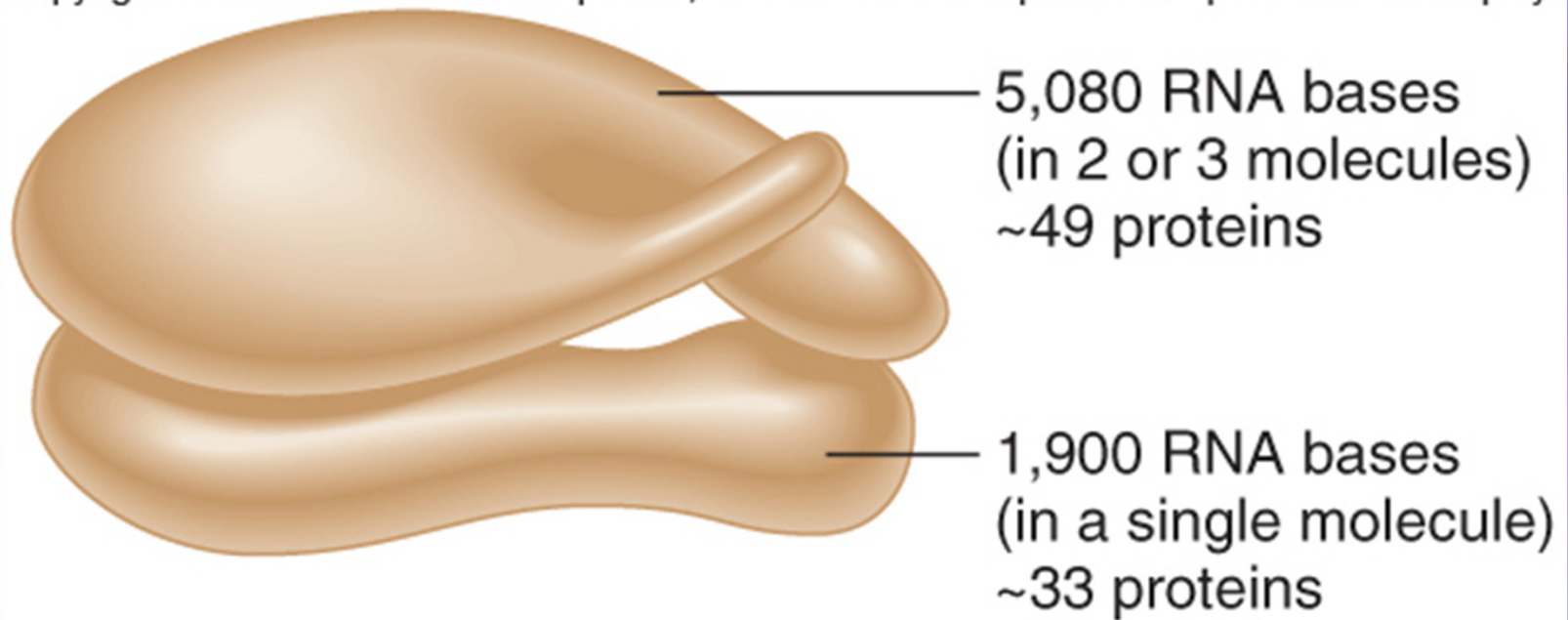
- Important component of ribosomes

3. Transfer RNA (tRNA)

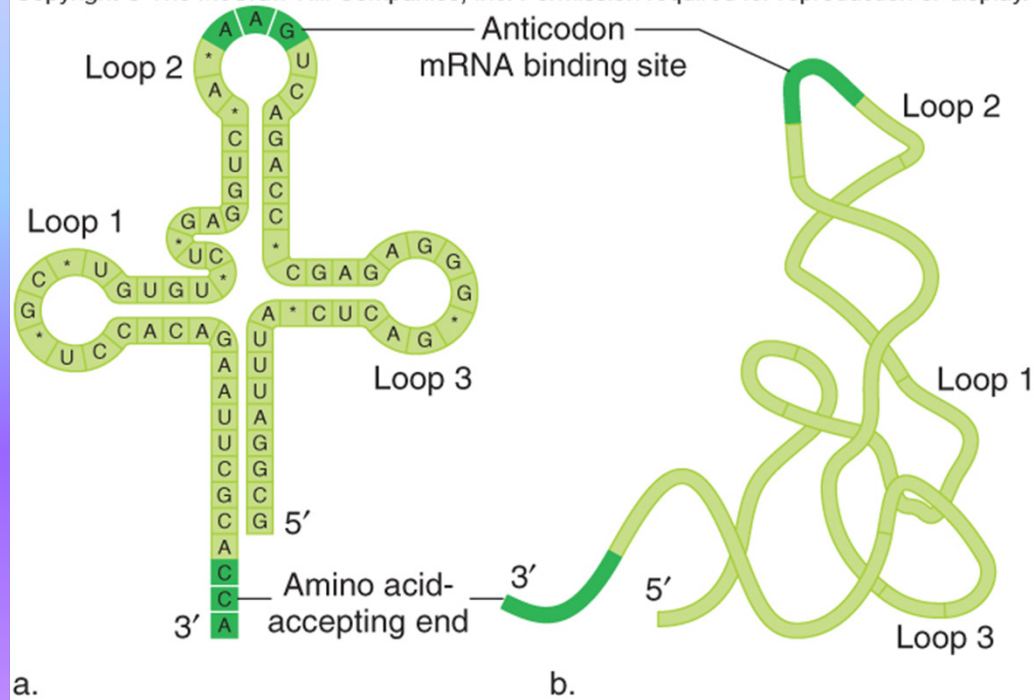
- Carries amino acids to ribosomes during protein synthesis

rRNA

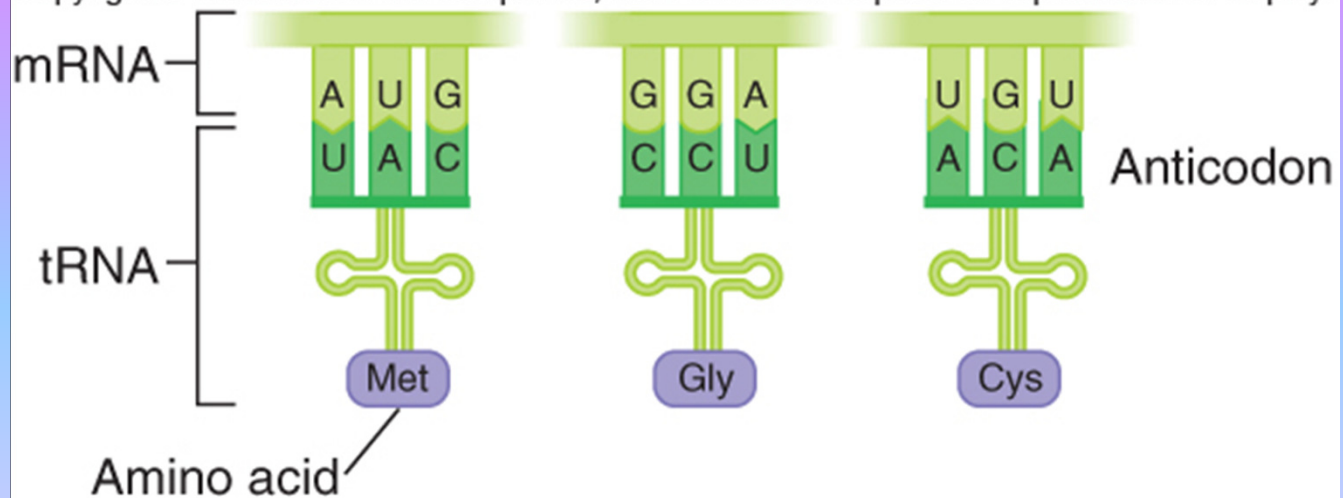
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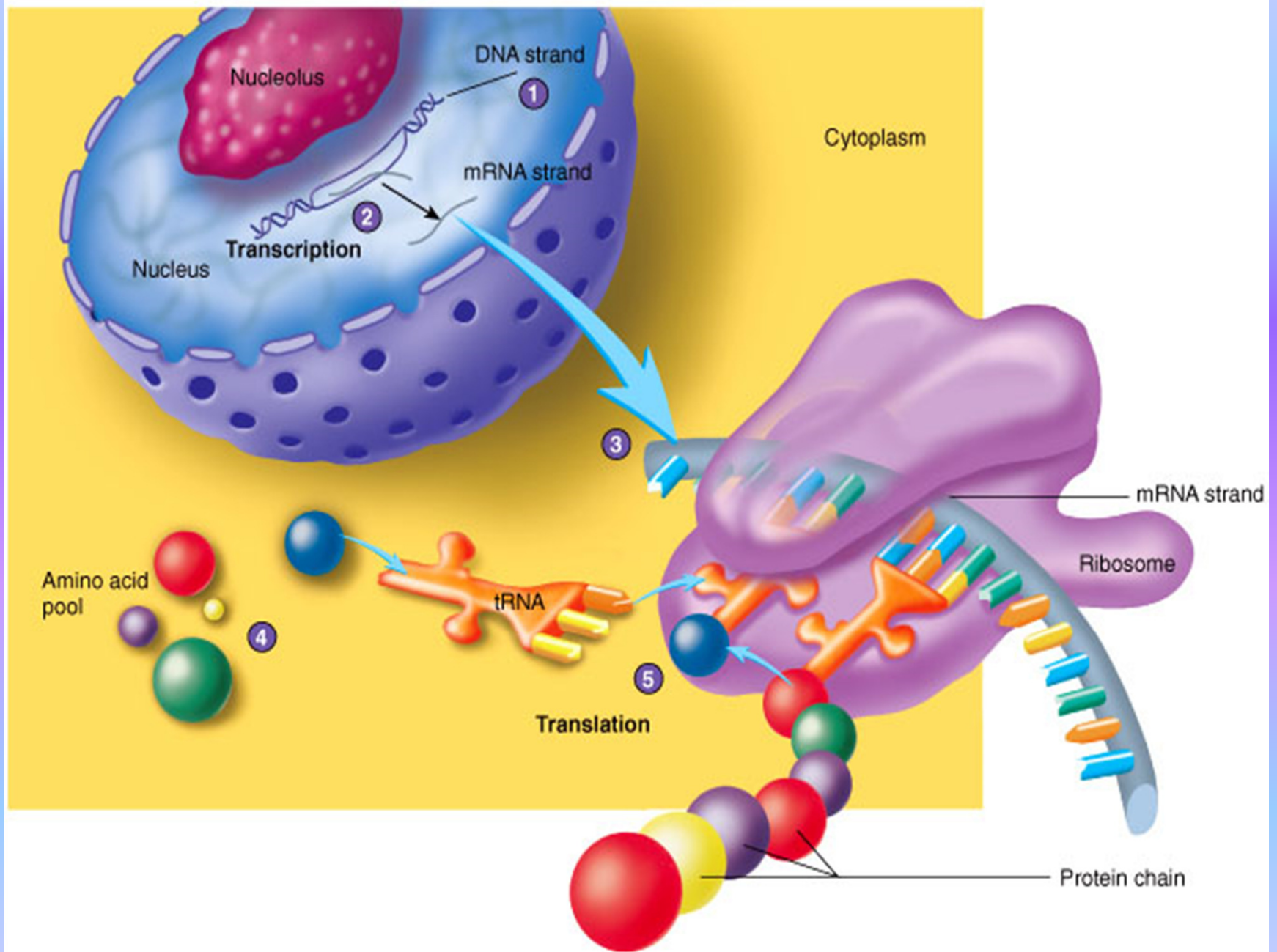
- **Transcription** =

- Synthesis of RNA from DNA template
- Eukaryotes
 - Occurs in nucleus
- Prokaryotes
 - Occurs in cytoplasm

- **Translation** =

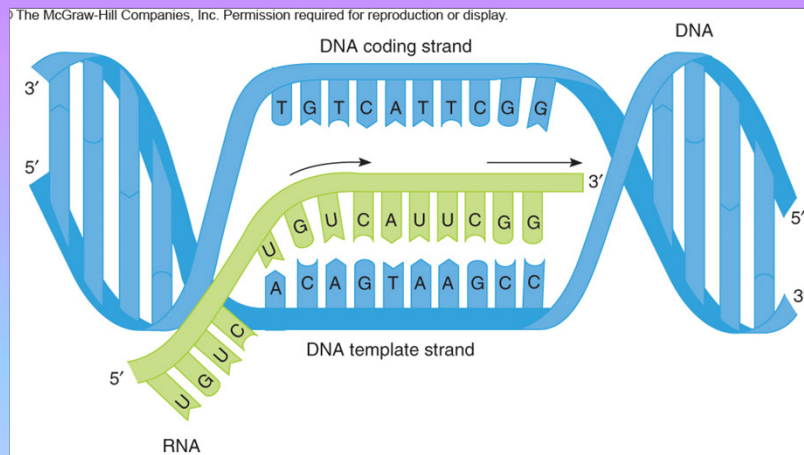
- mRNA is converted into sequence of amino acids of a protein
- Eukaryotes AND prokaryotes
 - Occurs in cytoplasm at ribosomes





RNA Synthesis: Transcription

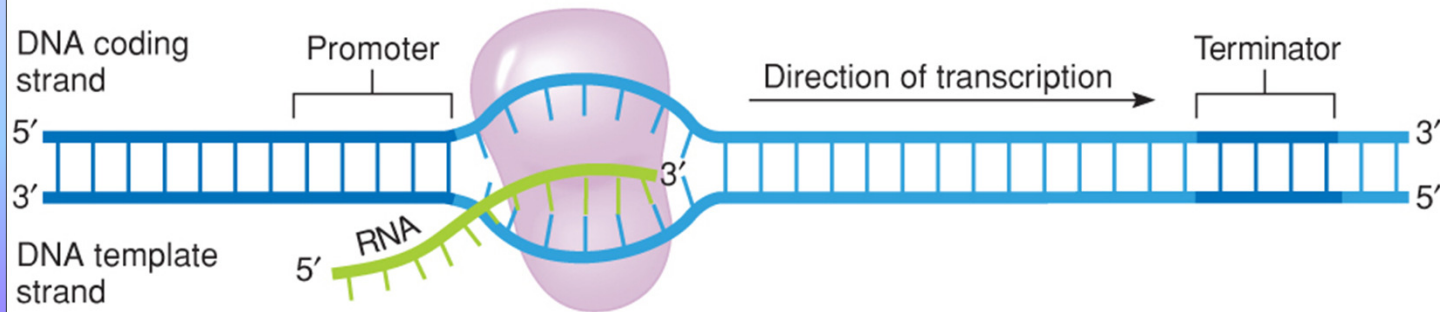
- **Promoter** =
 - Specific region of a gene where RNA polymerase binds and begins transcription
- **RNA polymerase** =
 - Enzyme that links RNA nucleotides using DNA as a template
 - Adds complementary RNA nucleotides along DNA template strand



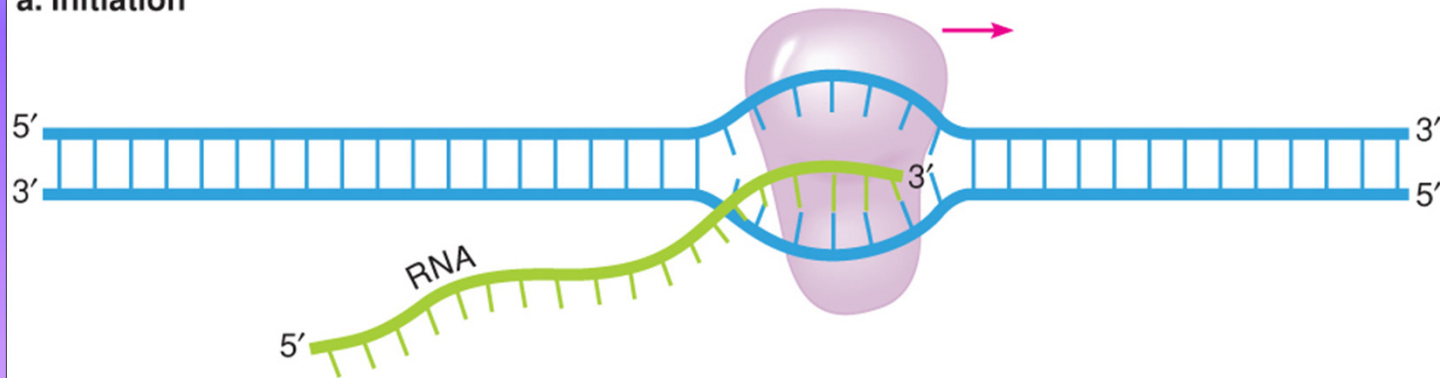
-RNA's C pairs with DNA's G
 -RNA's G pairs with DNA's C
 -RNA's A pairs with DNA's T
 -RNA's U pairs with DNA's A

- Synthesized in 5' to 3' direction

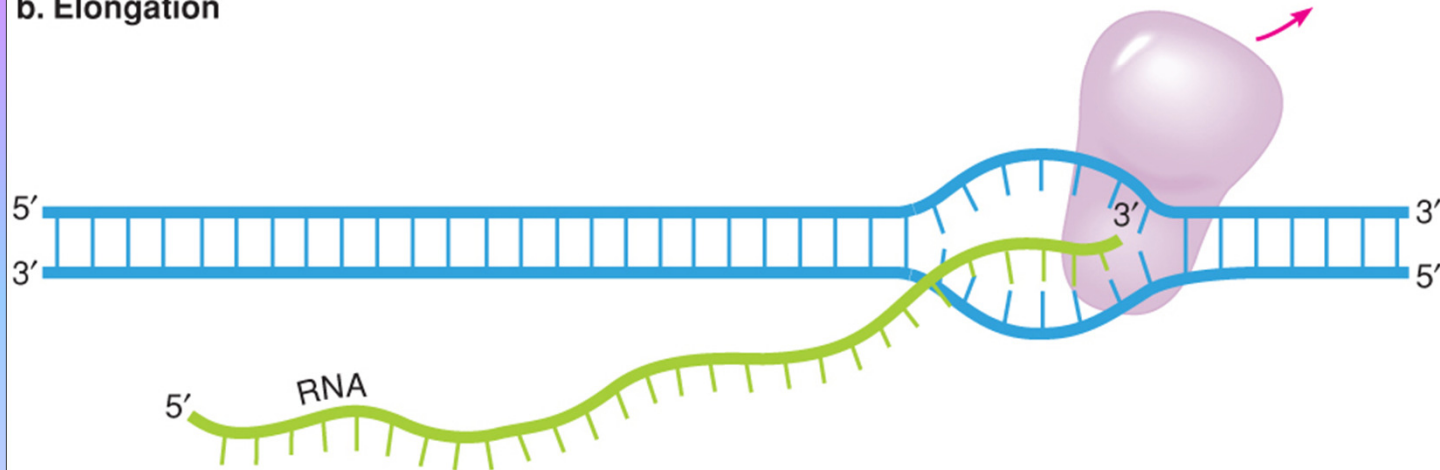
RNA polymerase



a. Initiation



b. Elongation



c. Termination



Let's Practice!

- DNA template strand

C C T A G C T A C

- RNA

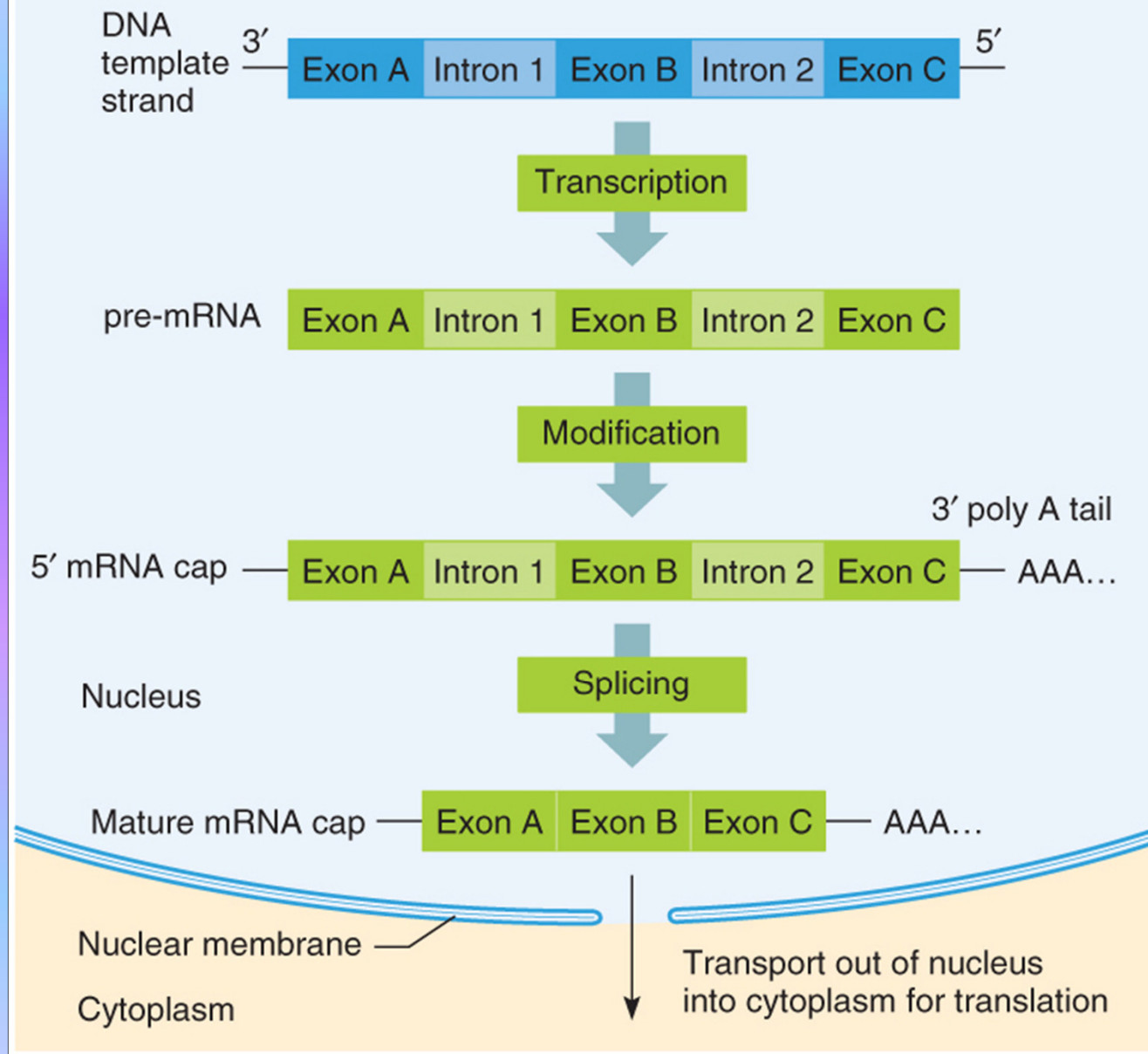
G G A U C G A U G

- DNA coding strand

G G A T C G A T G

RNA Editing

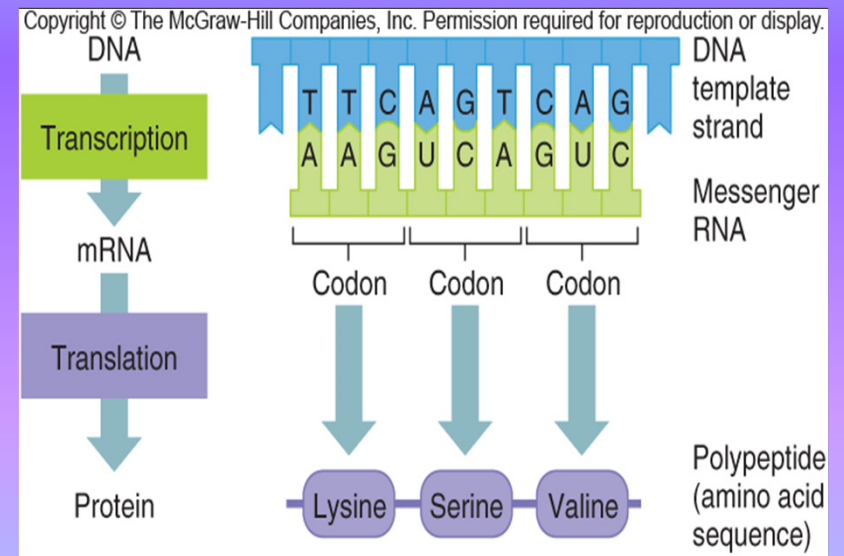
- **Introns** =
 - Sequences of DNA that are not involved in coding for a protein
 - Transcribed but then removed before translation
- **Exons** =
 - Sequences of DNA that code for proteins
 - Spliced back together to be translated



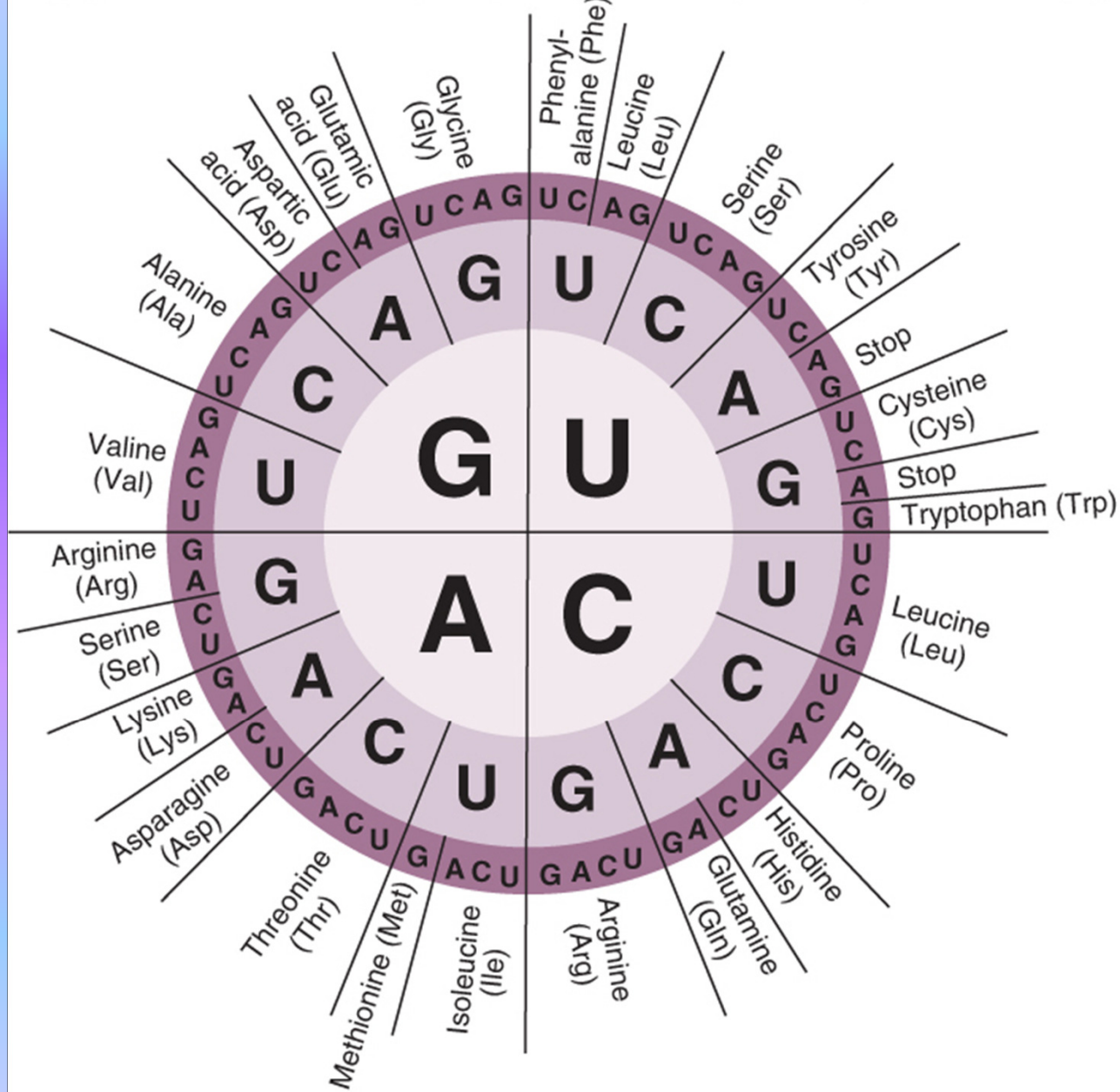
Protein Synthesis: Translation

Genetic code =

- Correspondence between specific mRNA triplets and the amino acids they specify
- Codon =
 - Group of **3** nucleotide bases in **mRNA** that specify a particular amino acid
 - AUG is the “start” codon
 - UGA, UAA, and UAG are “stop” codons
- Universal
 - All species use the same mRNA codons to specify the same amino acids



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Let's Practice!

- mRNA

AUGGGAUGUAAGCGAUAA

- mRNA codons

AUG GGA UGU AAG CGA UAA

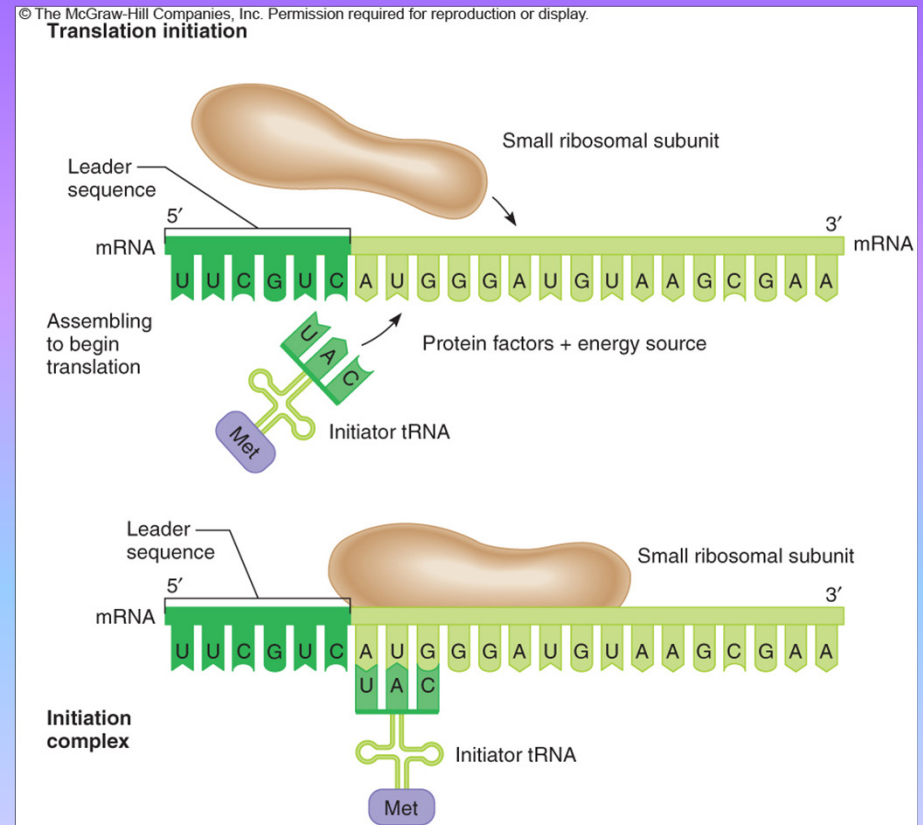
- Amino Acid

Met Gly Cys Lys Arg (STOP)

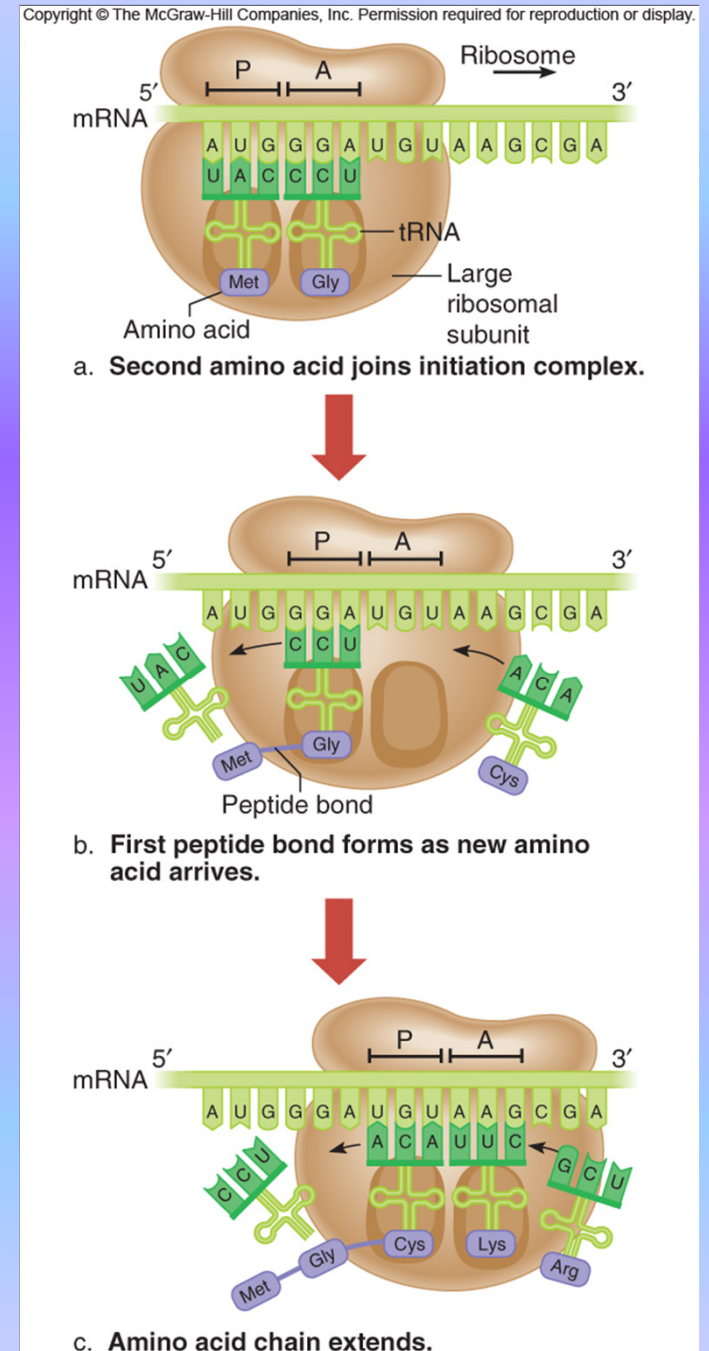
Steps in Translation to Build a Protein

- Ribosome attaches to mRNA in cytoplasm
- Proper amino acids are brought to codons with help of **anticodons** =

– Group of **3** bases on **tRNA** that are complementary to mRNA codon and carry appropriate amino acid



- Start codon (AUG) attracts tRNA carrying the amino acid methionine (Met)
 - Indicates start of polypeptide
- tRNA brings next amino acid to A site of ribosome
- P site next to it holds growing amino acid chain
 - **Peptide bond** forms between adjacent amino acids, creating a **polypeptide chain**
- When “Stop” codon reaches the A site, the new polypeptide and mRNA are released





Let's Practice!

- DNA

TACGGTCGTTCGAATATC

- mRNA codons

AUG CCA GCA AGC UUA UAG

- tRNA anticodons

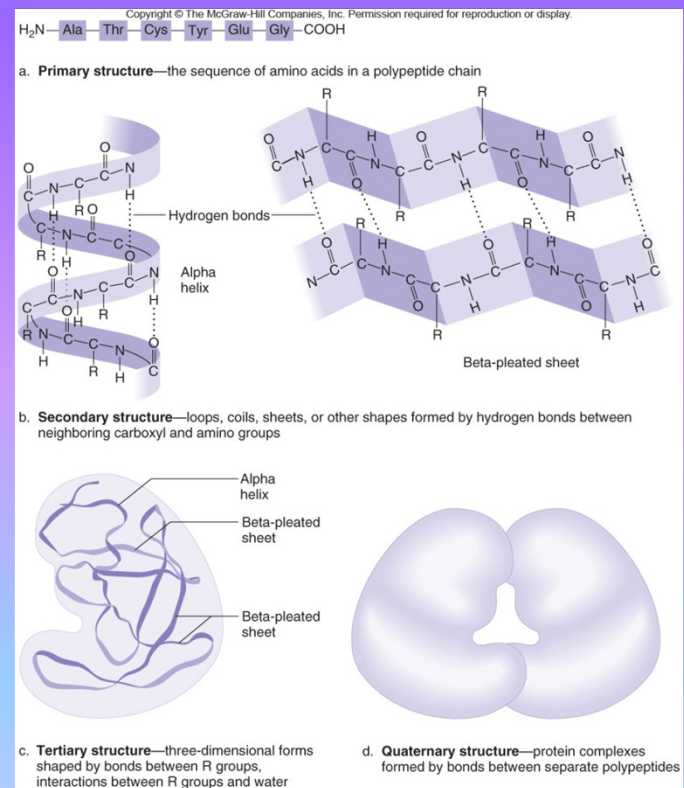
UAC GGU CGU UCG AAU AUC

- Amino Acid (remember to use the codons!)

Met Pro Ala Ser Leu (STOP)

Protein Modification

- Proteins fold into one or more 3-D shapes
 - Remember, shape affects function!
- **Chaperone proteins** =
 - Binds a polypeptide and guides folding
- **Proteasome** =
 - Refolds or dismantles misfolded proteins
- Example of folding error:
 - Sickle cell disease
 - Red blood cells are bent out of shape



Mutations

- **Mutation** =

- Change in the genetic material of a cell

- Alters DNA sequence
 - May or may not affect phenotype

- 2 basic categories:

- Chromosomal mutations
 - Gene mutations

- **Point mutations** =

- » Single base pair in DNA is changed

- » Generally occur during replication

- » Ex: Substitutions, insertions, deletions

- **Substitution** =

- One base is changed to a different base
- Results in change of one codon
- Examples

- **Missense mutation** =

- One amino acid is altered

- **Nonsense mutation** =

- Protein is shortened because new codon is a “STOP” codon

- **Silent mutation** =

- No change in amino acid
- 3rd base of triplet was altered to codon that specifies the same amino acid

- **Frameshift mutations** =
 - Shifts “reading frame” of genetic message
 - Alters every amino acid that follows the mutation
 - Examples
 - **Insertion** =
 - One base is added to DNA sequence
 - **Deletion**
 - One base is removed from DNA sequence
- Note: If bases are inserted/deleted in multiples of 3, reading frame is not altered

Effects of mutations

- **Mutagens** =
 - Agents in environment that interact with DNA and may cause a mutation by:
 - Interfering with base pairing
 - Increases errors in DNA replication
 - Weakening DNA strand
 - Causes breaks and inversions on chromosomes
 - Examples
 - Chemical
 - Pesticides, tobacco smoke, environmental pollutants
 - Physical
 - Radiation (X rays, UV light)

- Harmful effects
 - Cancer and other genetic disorders
- Beneficial effects
 - Resistance
 - **Polyploidy** = extra sets of chromosomes
 - Results in larger and stronger plants
 - Increase genetic variability in a species
- Many mutations are neutral
 - May not even change any amino acids